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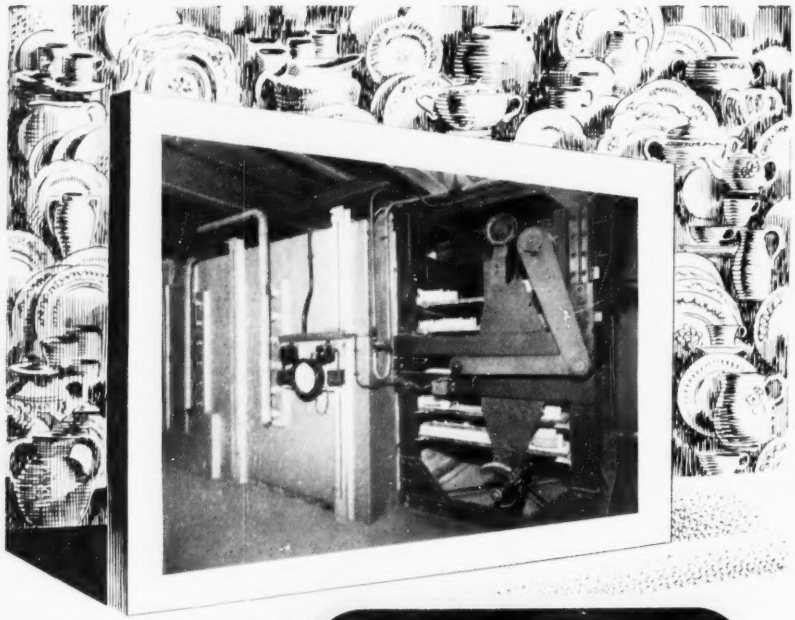

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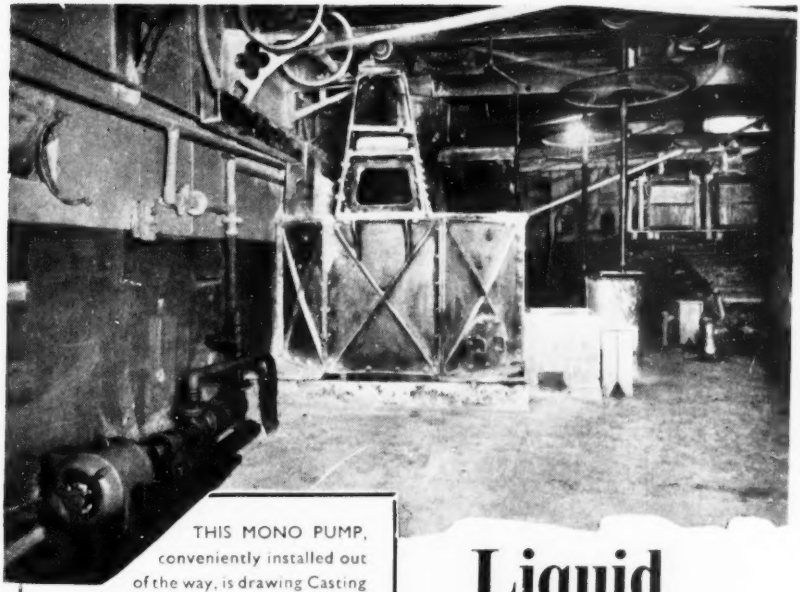

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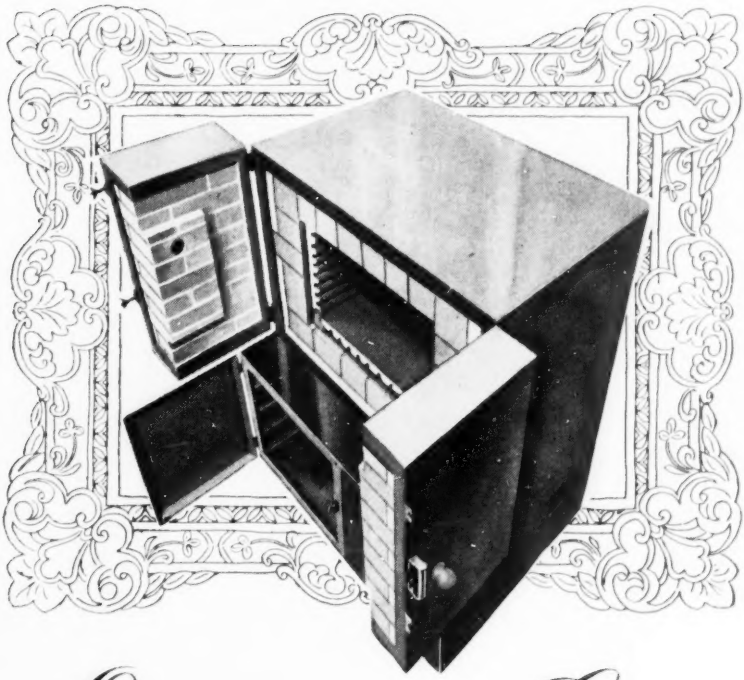

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CERAMICS

OCTOBER 1953

FEATURE ARTICLES

MISCELLANEOUS

A monthly journal covering the whole ceramic field including pottery, glass, heavy clay, refractory and silicate industries.

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Ceramics

VOL. V OCTOBER, 1953 NO. 56

Ceramics Symposium

CONGRATULATIONS to the British Ceramic Society, for to mark the occasion of their 1950 Jubilee they are publishing a volume reviewing the progress made in the science and technology of ceramics during the Society's lifetime.

This has been a momentous task, but from the comprehensive list of authors names there seems little doubt that the book will become a classic in a field which has badly needed such a contribution for many years.

Until CERAMICS was published monthly there was indeed a marked paucity of technological information available and looking through the authors names in the new symposium we are pleased to note many names which have appeared in CERAMICS in the past year or so.

To the scientist the section dealing with the physical and chemical constitution of ceramic materials will be invaluable. On the pottery side, electrical porcelain, glazes, saggers and kiln furniture, drying, firing and testing are covered. Refractories, from fireclays to super refractories, are dealt with, while chapters are included on steel, blast furnace and gas industry applications. The book concludes with a section on heavy clay ware.

Reservation now is well worth while, from the British Ceramic Society, North Staffordshire Technical College, Stoke-on-Trent—price £2 5s. 0d. + 2s. 0d. postage to members, or £3 5s. 0d. + 2s. 0d. postage to non-members.

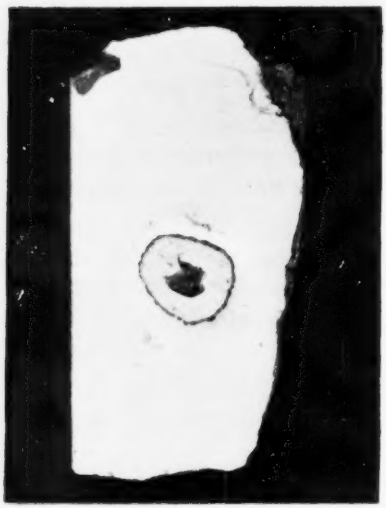
The Role of Iron Compounds in Ceramic Materials and Processes

(SPECIALLY CONTRIBUTED)

THE natural clays all contain quantities of iron compounds and, except where they confer desirable colours in the finished clay product as with some bricks, tiles and quarries, are regarded as a nuisance.

The amount of iron compounds in clays (calculated as ferric oxide Fe_2O_3) varies from 0·5 per cent. or less in china clay, through ball clays and fire clays where the amount may be up to 3·0 per cent. or a little over, to the red clays with up to 10 per cent. With the ball clays it is generally reckoned that for a white-burning clay the sum of the percentages of ferric oxide and titania (TiO_2) should be below 2·0 per cent. Above this buff-burning clays are to be expected.

Iron compounds occur in clays in various mineral forms, such as the hydrated oxide limonite $Fe_2O_3 \cdot H_2O$, sulphides such as pyrites, marcasite (FeS_2), copper pyrites $CuFeS_2$ such as chalcopyrite and embescite, the carbonate $FeCO_3$ siderite, and the oxide haematite Fe_2O_3. There is also an iron analogue to kaolinite $Fe_2O_3 \cdot 2SiO_2 \cdot 2H_2O$ which is colloidal. These compounds, if present in sufficient amount, can cause staining of the clay. The grain size and the presence of titania also influences the degree of staining, finer grinding increasing it. Because of this the fine-grained iron-bearing marls usually stain more powerfully than added iron oxide or similar compound in equivalent amounts.



Example of "blow-out" caused by pyrites in sanitary ware

'Green spot" in fireclay sanitary ware caused by copper pyrites

Decomposition of Sulphides and Carbonates

The sulphide and carbonate minerals undergo decomposition on heating, giving off gases, e.g.:

$$FeCO_3 = FeO + CO_2$$
$$2FeO + \tfrac{1}{2}O_2 = Fe_2O_3$$
and $$4FeS_2 + 11O_2 = 2Fe_2O_3 + 8SO_2.$$

Provided the minerals are present in fine particles the gas may escape harmlessly, but when they occur in bigger lumps, as they do sometimes in fireclays used for sanitary ware, it is necessary to grind the marl and screen it. This is usually done through a 12 or 16 mesh and the iron compound should then only cause specking. Occasionally, however, a hole in the screen may let through a larger particle, and then a hole may be blown in the body. This fault is called "blow out."

Where copper pyrites is involved and the blow out penetrates engobe and glaze, one obtains the fault called "green spot." This takes the form of a hole filled with a black ferruginous slag surrounded by a green coloration, where the copper compound has dissolved in the glaze.

In this connection it is interesting to note that when fireclay sanitary ware was first fired in tunnel ovens it was found on occasions that some pieces had a large number of fine green specks in the glaze. This fault had not occurred in intermittent firing. Investigation showed that this was due to the fact that copper compounds are volatile. The longer firing time in the intermittent oven allowed the vaporisation of these fine green specks, whereas in the faster tunnel oven firing they remained (cf. A. W. Norris, *Trans. Brit. Cer. Soc.* **52**, 111, 1953).

Another source of loss due to the presence of pyrite and siderite in fireclays is the spurting of pieces of clay on to ware caused by their presence and decomposition in wad clay and occasionally in saggars.

Specking of Whiteware

Ball clays used in whiteware normally contain 1·5 per cent. or less of ferric oxide in the form of hydrated ferric oxide, and occasionally as marcasite. Under normal firing conditions the presence of these iron compounds causes no trouble. When, however, there is a slow dragging fire in the early stages in a coal-fired oven it is possible for water to condense on the green ware in the saggars. This water will normally contain sulphuric acid derived from oxide of sulphur and steam formed in the combustion of the fuel. This acid can dissolve iron compounds from the clay, forming sulphate of iron solution. As heating proceeds this solution evaporates and migrates to portions of the ware which are still relatively cool and damp, in the same way that a pond dries up. Finally, the sulphate of iron is concentrated in one area and dries out there. Subsequent heating decomposes this reforming iron oxide, and thus it comes about that a quantity of iron, too small to cause general specking, may produce a localised effect. The remedy lies in the firing.

Section of blue brick showing formation of ferrous compounds on outside by action of reducing gases

Effect of Composition and Firing Condition on Colour of Fired Clays Containing Iron

It is well known that firing conditions can alter the colour of ferruginous clay products. This arises from

the fact that the oxides and silicates of iron have different colours. Thus ferrous compounds produce bluish colours, as shown in the Staffordshire blue bricks and tiles, and since ferrous compounds flux readily with silica these products are well vitrified and are often specified for engineering work. They are produced by firing a red clay under reducing conditions produced by filling the kiln with smoke in the later stages of firing.

As an example of the strength imparted by the extra vitrification caused by the fluxing of the ferrous compounds, the following figures are instructive:

	Mean crushing strength (lb./in.²)
Hand-made bricks (extreme range)†	1,000- 8,500
Machine-made bricks (extreme range)†	500-15,000
Common bricks	500-10,000
Stafford Blue bricks (Grade A) B.S.S. 1301, 1946	10,000 and upwards
Stafford Blue bricks (Grade B) B.S.S. 1301, 1946	7,000-10,000

† From National Building Studies Bulletin No. 1. H.M.S.O.

Ferric compounds, as typified by ferric oxide Fe_2O_3, produce the normal red colour in bricks and tiles. The exact shade is conditioned by the grain size and by the presence of other minerals in the clay. At higher temperatures the red ferric oxide is changed in oxidising atmospheres to Fe_3O_4, the magnetic oxide, which is black:

$$3Fe_2O_3 \underset{\text{(over 1,000° C.)}}{\rightleftharpoons} 2Fe_3O_4 + \tfrac{1}{2}O_2$$

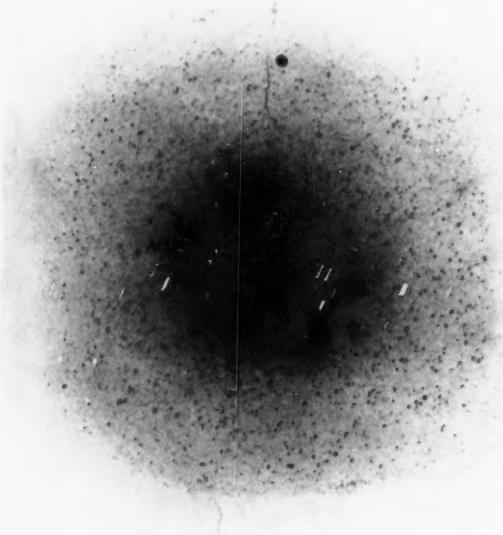
(red) (black)

This accounts for the darkening of white and ivory wares when overfired.

The presence of other chemical compounds can profoundly affect the fired colour of claywares, though the exact mechanism of the reactions is still a matter of speculation. Clays containing lime and magnesium compounds normally burn to a lighter colour than when these are absent. Alumina can also act in the same way. The presence of carbon in the clay can also lead to some interesting effects if not burnt out correctly.

Pink Hearts in Buff Tiles

Wall tiles are often made nowadays from fireclays, when the colour of the tile is to be masked by mottling with an opaque glaze. Such clays contain carbon, and if the firing is incorrectly done; that is if it is too quick in the



Example of pink centre in buff tile

early stages, a pink heart may be seen in the buff biscuit tile.

The probable explanation of this and of red centres in buff bricks is as follows (cf. J. W. Mellor and B. Moore, *Trans. Brit. Ceram. Soc.* **16,** 58, 1916-17). It is considered that the red colour produced by ferric oxide in the clay (ferric oxide as far as is known does not combine to form silicates in the body) is modified in some way by the alumina present over a certain temperature range, producing a buff colour. The pink centre probably contained carbonaceous matter which, due to hurried firing and lack of oxygen, did not burn out until a higher temperature than normal had been reached. Ferric oxide was then left as a red coloration, since at the higher temperature the bleaching agent was no longer able to turn it buff. Cases have been noted where buff bricks showed pink hearts, and pink outside edges. The latter are considered to be due to a breakdown in the buff iron oxide-alumina complex which is postulated as the cause of bleaching. This happens when the alumina content of the brick is low.

Sand Facing

It should be noted that where it is necessary to produce a variety of colours from the same clay as with roofing tiles and occasionally with facing bricks, sand facing is often resorted to. This consists of coating the clay article with a sand which burns to the required colour, or with a mixture of sand and some chemical such as manganese oxide (which produces a deep brown colour). The sand mixture is caused to adhere to the clay by softening the surface with steam and blowing on the sand with compressed air. The articles are then fired and the sand is fused or sintered on to the brick or tile, producing at the same time the desired colour. In this way clays of inferior quality can be made to give attractively coloured ware though, of course, at an increased cost.

Failure of Certain Refractories

Particles of iron compounds in refractory bricks can cause failures since they can catalyse the breakdown of carbon monoxide with the deposition of carbon in the pores of the brick at about 500° C.:

$$2CO \longrightarrow 2C + O_2$$

It has been found that the growth of carbon can eventually cause the bricks to fall apart.

Removal of Iron Compounds from Clays

The removal of iron compounds from clays has exercised the minds of ceramists for a very long time. With fine ware it is possible to blunge the clay, and then to lawn it and pass it over magnets to remove magnetic iron compounds.

It should be noted that magnetting does not remove all iron compounds since some are not magnetic, but nevertheless, the practice does produce a clay which answers very well for whiteware. Obviously this method would be too expensive for bricks and similar ware.

Dry grinding and sieving will remove the coarser lumps of iron compounds, but the mesh is usually of necessity too big to prevent specking of the ware. With many products this does not matter. Fireclays are often allowed to weather before being ground and used. In this way the larger lumps of marcasite and embescite are decomposed by the action of air and water. The product is first ferrous sulphate and later ferric oxide. This leaves the characteristic rusty stain on clay lumps which can then be picked out. Unfortunately, there are some kinds of pyrites which do not weather readily. Heavy clays are sometimes passed over magnetic pulleys by conveyor belts. This will remove lumps of tramp iron, but it is seldom effective on iron compounds as they are usually coated with clay.

It has been suggested that treatment of heated clay with chlorine or aluminium chloride would remove the iron as volatile ferric chloride, but such a method is too expensive for commercial application.

Iron Compounds in Glazes

Iron oxide can be dissolved in glazes to produce yellow and brown colours, the shade depending on the amount added. Leadless glazes tend to produce poor effects since they contain materials which tend to bleach the colours. Normally, a glaze may be expected to dissolve about 5 per cent. of iron oxide and amounts added

above about 7 per cent. may be thrown out of the glaze on cooling giving a scummed effect. A great excess of iron oxide (20-30 per cent.) added to a glaze, especially an alkaline one, give the well-known aventurine glaze in which small gold spangles appear in brownish-red glaze (see "Crystal Glazes," *Ceramics*, **4**, 56, 1952.)

Celadon Greens

Celadon greens owe their colour to the presence of iron compounds in the glaze. Connoisseurs ascribe the origin of the word celadon either to Saladin the Sultan of Egypt, who sent a gift of green coloured porcelain to the Sultan of Damascus in 1171, or to the distinct green colour of a coat worn by a shepherd called Celadon in a seventeenth-century play.

Whatever the origin of the word, celadon is a term which nowadays is understood to describe a set of colours varying from light green, through bluish-greens to quite intense greens, depending on the amount of iron present. The iron is, at any rate, in part in the ferrous condition, and the colour is produced by firing under reducing conditions. Analyses of samples of old celadon glazes have established the fact the iron present is mainly in the ferrous condition with small amounts of ferric compounds. There were no traces of other elements which normally produce greens in glazes.

The ancient Chinese did not, of course, deliberately introduce iron compounds into their glazes, rather they were present in the materials from which the glazes were produced. The exact tint depended on various factors. The ratio of ferrous to ferric compounds affected the colour. Increasing amounts of ferric tended to give brownish or yellowish (olive) greens. Variations in the lime and alkali content in the glaze could also affect the colour, as also did gas bubbles.

Underglaze colours

The oxide itself is too soluble to be used as an under-glaze colour for printed decorations, etc. It is used in conjunction with antimony and lead oxides in yellow and orange colours intended for under-glaze application. Binns (*Manual of Practical Pottery*, London, 1922) gives the following recipes:

Under-glaze yellow	*Under-glaze yellow*
7½ lb. pot. antimonate	4 lb. crude antimony
11 lb. red lead	6 lb. red lead
6 lb. iron oxide	2 lb. crocus martis
	1½ lb. tin oxide

Crocus martis is an iron oxide. The ingredients are heated together to easy glost temperature, washed, ground, and dried.

On-glaze Iron Colours

When ferrous sulphate crystals, $FeSO_4 \cdot 7H_2O$, are carefully heated a series of red colours can be obtained depending on the calcination temperatures. In general, the bright reds are obtained by calcination around 600-650° C. and at higher temperatures (800-1,000° C.) the colour takes on a violet cast. There are a variety of shades. At 600° C. the product is referred to as nasturtium red and the presence of a little alum with the ferrous sulphate facilitates the formation of the colour and stabilises it. Sometimes a little zinc oxide is added for the same purpose (cf. Mellor and Meir [*vide supra*]). The iron coral red is formed at 650° C. and blood red at 700° C. After 750° C. (cornelian) further heating to 800° C. begins to produce violet tints. For bright colours it is recommended that cooling be done in the absence of air. After washing and grinding, these colours are fluxed with a low alkali flux such as No. 8 flux (flint 1, red lead 3, borax 2). The reason for this is to prevent dissolution of the colour in the flux with the production of yellow stains.

G. E. Meir and J. W. Mellor (*Trans. Brit. Ceram. Soc.* **36**, 32, 1937) studied the production of iron oxide colours and have given details of the celebrated iron red on-glaze colours produced by M. Parmetier in Paris in the early nineteenth century. These were produced by calcining ferrous sulphate, and mixing with 20 per cent. of a flux made from silica 4 parts, litharge (PbO) 12 parts, and borax 3 parts. In this way eleven colours were produced. These were analysed by A. Solvétat (*Ann. Chim. Phys.* (3) 27, 333, 1949. Mémoires de Chimie, Paris, **9**, 1868) and the details are given in Mellor and Meir's paper, which also reproduces the tints in colour, and very beautiful they are. Natural iron earths such as the siennas and ochres

were once used for iron colours. Their composition is variable, and nowadays they are little used.

Thiviers earth is worthy of mention since on calcination it produces Japanese Red. This was formerly used as a pink body stain for earthenware and is still used occasionally for producing a flesh tint.

1	2	3
Enamel brown	*Under glaze brown*	*Red brown (U.G.)*
40 lb. zinc oxide	5¼ lb. iron chromate	31 lb. manganese (oxide)
6 lb. red iron oxide	2 lb. manganese (oxide)	6 lb. red lead
6 lb. chromium oxide	1 lb. black antimony	3½ lb. ground glass
5 lb. litharge	1 lb. crocus martis	6 lb. flint
5 lb. boracic acid	¼ lb. red lead	3½ lb. borax
Calcine to biscuit temperature	Calcine as 1	Calcine in glost oven

Compound Colours Containing Iron Compounds

Brown and black colours contain iron compounds, and the materials used are usually ferric oxide or sometimes iron chromate. The latter introduces both chromium and iron oxides.

J. R. Adderley (*Trans Brit. Cer. Soc.*, **15**, 133, 1916) studied the brown colours produced when a mixture of equal parts of ferric oxide and chromic oxide was treated with varying proportions of china clay and zinc oxide. Increasing zinc oxide developed the warmer brown colours, while the alumina from the china clay darkened the shade to a sepia tint. The chart reproduced in this paper shows how a whole variety of brown colours can be produced from mixtures of ferric oxide, chromium oxide, china clay, and zinc oxide. Zinc and iron oxides alone will produce browns, but the colour is more stable when chromium oxide is present.

The number of recipes for brown colours is legion, and other ingredients find their way into the recipes to give particular colours. These include red lead, lead chromate (to confer yellowish tints to the brown) manganese oxide (to darken the colour) and nickel oxide. Examples of recipes taken from C. F. Binns (*Manual of Practical Pottery*, Second Edition, London) are as follows:

Blacks

Addition of cobalt oxide to browns gives blacks. Meir and Mellor (loc cit.) quote the following recipe for a good underglaze black:

Cobalt oxide	...	31
Chromium oxide	...	7
Ferric oxide	...	36·2
Manganese oxide	...	12
Nickel oxide	...	12·8

This is calcined and treated in the usual way. These authors comment on the fact that if the proportions of the oxides do not balance properly the black will be affected. Thus excess of cobalt oxide gives a bluish-black, and so on. Mellor comments that the stability of complex colours is lessened as the number of ingredients rises and when a black is overfired the colour may appear blue, due to the colouring properties of the other oxides being lessened, while the very stable blue remains unaffected.

Similarly, bad preparation of the colour may lead to preferential solution of one of the ingredients, as when blue haloes are seen around black bands due to preferential solution of the cobalt.

Radicon Worm Reducers. We have received from the David Brown Corporation (Sales) Ltd. a copy of a new publication which gives full details and specifications of the company's range of Radicon Worm Reducers. These versatile units, which are among the most widely used of all standard David Brown products are made in a variety of sizes ranging from 1¼-in. to 28-in. centres. The 1¼ and 1½ size units (single and double reduction) are made by David Brown Gears (London) Ltd., the larger sizes being produced by David Brown and Sons (Huddersfield) Ltd.

Foster Transformers Ltd.—A leaflet describing their voltage regulating equipment has been issued by Foster Transformers Ltd., a "Lancashire Dynamo Holdings" Co. Copies of this list—FM.14 may be obtained from Foster Transformers Ltd., South Wimbledon, S.W.19.

Depreciation and Maintenance of Pottery Manufacturing Equipment

10—Self-Balancing Ledgers

by S. HOWARD WITHEY, F.Comm.A.

This series is designed to assist pottery manufacturers to adopt the most suitable methods of internal check and control and a reliable system of accounting. In previous articles the author discussed alternative methods of computing and recording depreciation in the capital value of specific manufacturing assets, also the problem of repairs and renewals, the incidence of interest on capital, the physical control of loose plant and tools and the creation of reserves, reserve funds and sinking funds and the control of the buying department. This article shows how a system of self-balancing ledgers can facilitate the compilation of the final accounts and balance sheet

WHEN the pottery manufacturer's financial books and accounts are being balanced at the termination of the working year or other period, many complicated problems usually arise before it is possible to view the results in true perspective, but experience has proved that comparatively little difficulty will be experienced in drafting the final accounts and balance sheet if a system of self-balancing ledgers is maintained. The adoption of the self-balancing principle reduces to a minimum the danger of errors and irregularities in the plant and personal ledgers and enables any necessary adjustments to be made before the periodical audit, and in order to avoid the necessity of checking a large number of accounts at the stocktaking date it is advisable to balance each ledger at the end of each month, and to do this the individual items entered in the subsidiary books would have to be suitably summarised.

Although the purchases journal, sales book and credit books can be entered up in the usual way, two additional columns should be ruled in the general cash book, one on the debit side and the other on the credit side, the former being headed "Sales Ledger" and the latter "Purchase Ledger." A monthly summary of the items recorded in the purchases journal and the sales and credit books can be readily made, and as the total of the items representing purchases of plant and materials will be posted in individual amounts to the credit side of the respective personal accounts kept in the purchases or bought ledger, the total should be recorded on the debit side of a reconciliation account opened in the same ledger. In like manner, as the individual items entered in the sales book will have been posted to the debit side of the particular personal accounts kept in the sales or customers' ledger, the monthly total of these items should be credited to a reconciliation account opened in that ledger.

If all the items recorded in the purchases credit book or returns outwards book (or in the end section of the purchases journal, as the case may be) have been posted to the debit side of accounts kept in the purchases ledger, the total of these items should be entered on the credit side of the Purchases Ledger Reconciliation Account. On the debit side of this account will be shown the balance brought forward from the previous month, this being the total of the purchases ledger balances outstanding as at the begin-

ning of the month; also the monthly total of the items as posted from the purchases journal to the credit side of the various personal accounts, and the total of any items credited from other ledgers; while on the credit side of the reconciliation should appear the total amount of cash paid to creditors, the discounts obtained in respect of the prompt settlement of accounts, and any transfers from other ledgers. The cash item should agree with the total of the cash book entries posted to the debit side of ledger accounts during the month, and the amount by which the total of the debit entries made in the reconciliation account exceeds the total of the credit entries should exactly correspond with the aggregate balances outstanding as at the end of the month.

If the cash book has not been ruled by the printer in a manner that would facilitate the separate balancing of the ledgers, an analysis should be made of the receipts and payments in order to determine the totals of the items posted to the different ledgers. In this connection, the constant transfer of accounts from one part of the ledger to another can be avoided by the use of perpetual ledgers consisting of loose sheets bound in a book file, or loose cards kept in a cabinet or drawer. These ledgers are now being used extensively by master potters as they allow either alphabetical or numerical arrangement or a combination of the two, and in addition to avoiding the frequent opening of new accounts there are no blanks to turn over, the utilisation of a division for "Closed Accounts" ensuring that only current accounts are handled. Each personal account always occupies the same position and consequently the monthly or other periodical statements of account can be much more readily checked.

When the balance of a reconciliation account differs from the total of the outstanding ledger balances, the maladjustment may be due to one or more original items having been posted more than once, or an amount may have been posted to the wrong side of an account, or it may be due to an incorrect casting of the figures recorded in a subsidiary book. As a rule it is not advisable to spend much time in looking for an error of a particular amount as unless the figure is an unusual one it would probably be very difficult to "spot"; it is better to check over that section of the book-keeping in which the discrepancy has arisen.

The accuracy of prices charged by suppliers and buying agents should be ensured and the figures ticked off on the various invoices and debiting documents, the senders being immediately notified of any errors, and full advantage should be taken of all discounts and rebates allowed for payment within stipulated or recognised periods. Potters can sometimes convert a financial loss into a net profit by settling accounts promptly and thereby securing maximum discounts and allowances.

Guard-book Method

In regard to the compilation of suppliers' accounts, some pottery manufacturers who are compelled to write up their books with little or no clerical assistance have adopted a method which enables each invoice and debit note to be referred to with the minimum of trouble and delay. As soon as the details have been checked and the invoice passed for payment, the form is neatly folded and endorsed on the back with the date, the name of the supplier or agent and the net cost price, the folded document being then pasted into a guard-book and the amount extended into a money column ruled down the right-hand margin. The invoiced cost prices of materials and equipment can then be posted direct to the credit side of the respective personal accounts kept in the purchases ledger, and the monthly totals debited to purchases account, but when this method is adopted special care is called for to differentiate between ordinary trade purchases and manufacturing assets, the cost of the latter being debited to an account or accounts opened in the private ledger. A separate book should be used for recording the amounts shown on credit notes received from suppliers, and these forms should be placed on a separate file. All invoices rendered by creditors should be preserved for future reference, and when invoices are passed through an invoice book the page of the latter should be inserted on each form.

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UPSALA-EKEBY

THE ancient Cathedral town of Uppsala in Sweden is not alone celebrated for its cultural and historic treasures. As long ago as the eleventh century clay pits were being worked at Upsala-Ekeby, four kilometres from the town, and brick-making was carried on there in the twelfth century.

In 1886 a pottery was founded close by the clay beds and today is a flourishing industry

The Upsala-Ekeby showrooms

AT the first sight of Ekeby, the visitor's preconceptions of a pottery vanish. Gone are the old picturesque but sooty beehive kilns, the last went in 1948, and in their place slender shafts rise above modern buildings dating mainly from 1951 when the plant was altered and extended. Power is derived from electricity and coke, and the buildings stand clean and bright amid a rural landscape.

The site was formerly a farm, much of which is still worked, and the produce either consumed by the staff or sold on the market. Senior executives and administrative staff are housed in adjacent villas among woodlands, and the wide Uppsala Plain stretches smilingly to the horizon. It looked an ideal place to work and live in.

The clay is not deep down. At a depth of only two metres a fine red burning clay is reached, and beneath it a yellow burning clay is found. These deposits from the Glacial Age are nowhere deeper than between 25-30 metres, and are the largest in Sweden. Twenty-thousand tons of clay are excavated annually, and 60 tons are converted daily in the factory.

The clay is dug in the autumn and prepared for use in a series of thirty slip ponds or basins, where it is left to ripen ready for use in the spring, since such operations are impossible in Sweden's winter period, lasting often from October to March.

Close to the slip basins are several drying houses equipped with a line of ventilating ducts set close to the floor, in which the clay is placed for storing when too moist. The moisture content of the clay used for tiles must average between 7-8 per cent.

The manufacturing process would seem to follow general practice. The slip is first mixed in ball-mills to the finest grade, and is then pumped to the filter presses. In this plant use is made of nylon filter cloths in preference to those of cotton, which require renewal every five to six months. These nylon cloths have been in use for three years now, and are still perfectly sound.

At Upsala-Ekeby they manufacture their own glazes, using oil-heated furnaces. A special test furnace is em-

ployed to achieve the correct degree of glaze required. The large quantities of tin and lead once used in glazing have largely been substituted by boric acid.

Since 75 per cent. of the output of the factory is wall tiles, the glaze is a most vital part of the operations. Lead, felspar, quartz, etc., go to its making, and the resulting product must conform to the very precise standards required.

The fully automatic tile presses of both German and British manufacture, working at a pressure of 400 kg. per sq. cm., achieve an output of 6-8,000 pieces each, making a combined output of 150,000 pieces per day. Powdered clay with a moisture content of 7-8 per cent. is fed from silos down to each machine where the tiles are removed by hand. Where round-edged tiles are in production, a second operative to the left of the machine minder takes each tile and rubs the rounded edge briskly once up and down on an abrasive surface before racking. Men and women operatives are employed at these machines, both as minders and assistants.

The racked tiles are conveyed by rail to the continuous double electric kilns for firing at a temperature of 960° C. for 70 hours. After firing they are removed manually and placed singly on to a travelling band, passing under a trip hammer before which an inspector sits listening for faults, and removing those not up to standard. A little to his right and facing him, a woman operative guides the tiles along a conveyor to an abrasive band which trims two edges. They pass on, to be turned 90° by a cant-wise stop and the other two edges are trimmed.

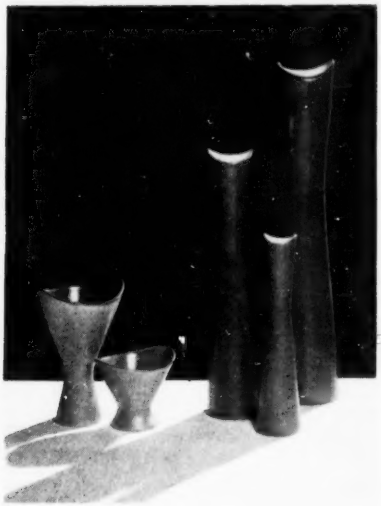
The tiles are then heated by hot air, are water sprayed, and pass through a continuous-feed glazing machine, emerging to have the glaze scraped from the edges by thin blades in a double operation as before. And so to the racks for a second firing in the tunnel kilns or in special push ovens which deal with 8,500 tiles each day, working in three shifts.

Upsala-Ekeby tiles are well known

in Scandinavia where extensive use of them is made in hospitals, notably at the new ultra-modern and massive Södersjukhuset in Stockholm, in the new underground stations in Stockholm, in breweries, bulk food stores, power stations, and car-washing halls. Certain weaving mills have also made use of these tiles for walls and floors.

The tiles are finally packed forty-four tiles to a pack which equals 1 sq. metre in area. The annual output is 45,000,000 tiles.

But tiles are not the exclusive product at Ekeby. Fully one-third of the output of this modern plant is concerned with art pottery and decorative wall tiles. Even the humble flower pot here assumes a delightful and practical shape, being made in a variety of sizes, and finished in glazes of those clear pastel blues, yellows and greens seen everywhere in Sweden.



Some are decorated with lustrous fish-scale patterns as a variation.

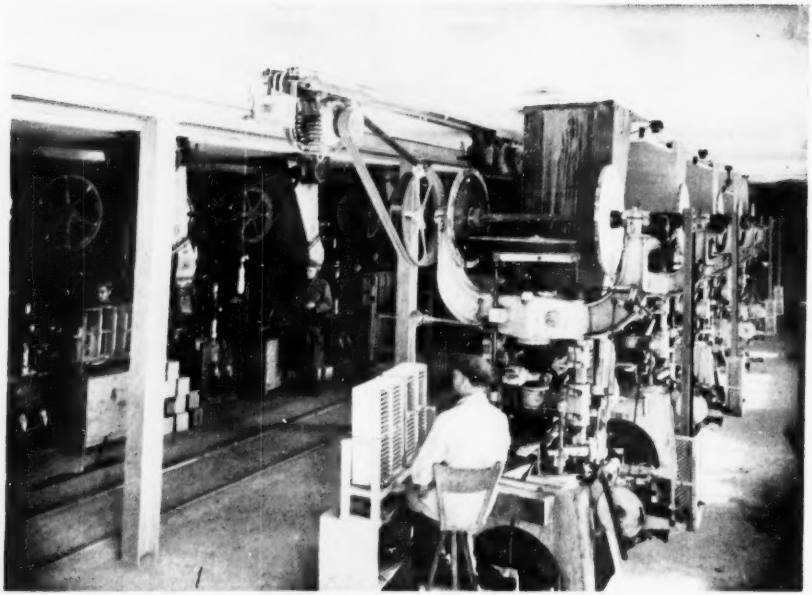
Economy in space when loading on to the cars or wagons of fire-brick ready for the ovens is secured by the use of stilts made at Stoke-on-Trent, smaller pots being inserted inside larger ones. The standard of decorative ware is very high.

The company is fortunate in having secured the services of several artists of great merit, such names as Sven Erik Skawonius, chief designer, Arthur Percy, Ingrid Atterberg, Anna Lisa Thomson (now deceased), and Mari Simmulson; Hjördis Oldfors and Mannerheim. Here in well-lighted ateliers, these artists are allowed to give rein to their creative inspirations, the results of which are revealed in the variety of designs and colourings in the workshops. We talked briefly with Mari Simmulson, an Estonian artist, who had trained also in Germany. In her atelier, with colourful flowers rivalling the glowing colours of her current creations, she told us that she has here found complete satisfaction in her work. Her designs have an Eastern tendency, something of the Caucasus we suggested, and were not surprised to learn that her ancestors came from Turkey.

In an adjacent studio an Indian lady creates designs evocative of her homeland, with fanciful touches of a more Western culture.

We visited the showroom filled with the creations of these and other artists. From this wide and beautiful range, outstanding as it is, certain pieces remain in the memory.

A huge wall fresco by Vicke Lindstrand, a saga of the potter's craft down the ages; a great vase by the same artist, inspired by a visit to Harlem in New York. Dishes and vases by Mari Simmulson, the glowing splashes of colour and unconventional lines revealing her inherited talent; food for thought here on the far-



Tile-making machines at Upsala-Ekeby

reaching influences of heredity.

All these creations have necessarily to become part of the general production of the factory, and other hands must be entrusted with the interpretation of their ideas.

The master designs go to the throwers, they are all men, under whose skilful and sensitive fingers a mass of clay grows into something owing much to the artist but revealing in its final shape the characteristics of the hand that formed it.

Some sixty throwers are employed, out of a total force of 700 workpeople. They range from lads learning to control the spinning masses to artists of many years' experience. Some of them come from foreign lands.

Here in the long sunny workroom hand and brain are wedded to create something beautiful and practical. Once again we saw the grey inert mass of clay take shape and grow into an object of fragile beauty, which will ultimately find a place in a shop window in Uppsala, in Kiruna beyond the Arctic Circle, or in the U.S.A.

It is a miracle which never ceases to inspire, as it has done for countless ages. The old-style throwing wheel has gone, one elderly worker alone remains with experience of footwork; today, all are powered electrically.

The decoration of the pieces is a further link in this inspiring chain. The motifs, pricked out on black paper, form the vehicle for reproduction, and girls sit under daylight lamps carefully scraping away those parts of the glaze not required in the final pattern. The bodies are then decorated by hand and proceed to the kilns. The result is closely akin to the original conception, yet reveals in a knife stroke, or a touch of the brush, that something wholly individual which is a hand-made product worthy to bear the seal U-E.

Naturally, where manifolding is possible, such as in the production of dishes or other household ware, moulds are resorted to. But even here the individual is discerned, and a careful inspection of the wares reveals that diversity in decoration which rescues them from any taint of uniformity.

The management at Ekeby is a progressive one. In 1923 the firm installed the first continuous tunnel kiln in Scandinavia, and today has a total of thirty kilns working, the largest of

which is 82 metres (270 ft.) long. Others are 60 metres (197 ft.) in length. The buying manager, Mr. Carl Monie, by whose courtesy we were shown over the plant, revealed that the health of the staff is a prime consideration, and that regular medical inspection is carried out. Silicosis is entirely absent from Ekeby, since the peculiar texture of the clay and the type of product obviate the need for extensive use of silicates.

As with most major enterprises in Sweden, the social welfare of the workers is considered. A large dining-room in a woodland setting is provided where excellent meals are served. There is also a swimming pool and recreational facilities.

Ekeby controls some ten enterprises, of which three are ceramic plants. There is Upsala-Ekeby, making wall tiles and art pottery, Gefle Porslinsfabrik manufacturing English style earthenware, and Karlskrona Porslinsfabrik making Continental china. AB Syntes, Nol, is a chemical works, the remainder specialise in building materials. The Upsala-Ekeby concern is under the management of Director Nils V. Sterner. At this well-sited factory at thø edge of the open countryside, there is an impression of people relaxed and happy in their creative tasks.

Application of Motion Study

by E. DANIELS

BEFORE I outline the principles of motion study we should have fixed in our mind some form of definition as to what it means, and to what its objectives are.

Motion study is simply a scientific investigation of human movements and of the tools, equipments and materials used in the performance of any process or operation.

Its objects are:

To find the most efficient and economical method of doing a job.

To minimise the effort and to reduce the fatigue.

To provide the best working conditions.

To standardise the jobs.

To provide a means of recording the job done for future reference.

With these objects in mind we can pass on to the application of the principles of motion study.

There are seven accepted basic principles used. First and foremost we have minimum movement.

One of the most obvious means of saving time and effort is, when ever possible, to reduce the distance which a worker has to reach for the articles he is handling. Apart from its effect on the worker's comfort such reduction is frequently a means of increasing output; yet it seldom receives the attention it deserves.

In any constructional job a worker must necessarily reach out his hands for tools and materials hundreds of times a day. If these can be brought nearer to him by a rearrangement of the articles themselves, a great deal may be done to relieve strain and to save time. This end can be achieved by arranging the tools and materials before the operator in a crescent-shaped form, perhaps crescent-shaped shelves to replace straight ones, by altering the height of the bench or by raising the back part of it.

The greater the reach the greater in proportion is the muscular strain involved. It is towards the end of a working day that these little extra efforts repeated time and again begin to have their ill effect.

The arrangement of equipment con-

A talk given on the 21st September, 1953, to the Stoke and Hanley Branch, British Pottery Managers' and Officials' Association.

cerns the worker's physical rather than his mental well-being, but the knowledge on every occasion, just where to put his hand on any article is a matter of far greater significance for him, than the distance through which his hands or body has to travel for it. The more repetitive the work is the more important this becomes.

If a worker is interrupted say twice a day, 10 min. each time, searching for some tool, or whatever it may be, he obviously loses time, but what is more important, he loses his temper also.

If this 20 min. of his time is lost in the sum total of many small delays the results will be far more serious so far as he is concerned. The breaking of his smooth working action will undoubtedly impair his efficiency.

To the best of his ability the worker generally arranges his equipment in a way to suit himself; but he needs some assistance, and that is not always forthcoming. The tools and materials used need shelves, tool racks, pigeon holes and drawers, probably with partitions, in order that they can be kept in certain places. These matters have to be first thought out carefully and experimented with before standardising and fixing permanently.

Secondly, we have symmetrical movement. The operator's left hand should be used only for movements on the left side of the body, and the right hand for movements on the right side. This eliminates the muscular exertion involved in twisting the body when either hand is used to pick up parts from the opposite side. Whenever possible this fact should be taken advantage of.

Symmetrical movement brings us to the third principle, that of simultaneous movement. As far as possible both arms should move in conjunction with each other to produce a balanced state of the body.

We should also aim at producing a rhythm in the cycle of movements. Successive movements should pass easily from one to the other. It is advisable to employ the method of "slow but sure" when applying the idea of rhythmical movement. A rhythm in the movement is of great advantage to the operator when learning a new method, and for that matter also during continued application.

Natural movements should be allowed to flourish. An unnatural movement should not be introduced to comply with any of the previous principles. Some natural movements are too often neglected, such as the independent use of the third and fourth fingers to hold a part in the palm of the hand while the thumb and remaining two fingers are carrying out an operation.

The sixth accepted principle is that of encouraging habitual movements which an operator may have acquired. However, some undesirable habitual movements may be encountered which will probably prove difficult to eliminate.

Last, but certainly not least, a continuous curved movement is preferred to sudden changing straight line movements. The use of a curved path permits the muscles to relax in part of their journey, whereas they are continually in a state of tension when experiencing sudden change in direction. It must be remembered also that every change in the direction involves extra time and effort.

Before we attempt to apply any of these principles to a job, a careful study of the surrounding working conditions should be made. Far too often this angle is neglected with drastic results.

Benches should be at about 33-34 in. high for general use, but the height should be selected above or below that level to suit the job. Where possible, the set-up should be made suitable for working sitting down or standing. Foot rests should be made available for sitting down jobs, of ample width and depth for the feet. Where a foot pedal is used a rest should be made so that the transfer from pedal to rest can be done smoothly.

Chairs should be made with adjustable back rests, whenever the job permits. Revolving chairs should only be used when the job requires it. In the case of a standing worker a captive seat provided under the bench can prove helpful.

Lighting should be so arranged to give ample brightness on the work place with the elimination of glare and the avoidance of heavy shadows.

Glare can be avoided by placing the lights well above eye level with adequate shades to cut off the direct rays.

All departments should make a

general rule of keeping lighting systems well cleaned, for an accumulation of dust over a number of weeks can cause a high percentage of loss. Not only does inadequate lighting cause bad quality of work, it increases the number of accidents.

Attention should be paid to heating in the workshop. The general accepted minimum temperature for comfortable working is about 60° F. This applies where there is a fair amount of movement and physical effort involved in the work. The type of heater which includes a small fan is of great use, as this circulates the warm air, giving a more uniform distribution of heat throughout.

Ventilation should be such that it provides an adequate number of changes of air per hour without creating a feeling of draught. The numbers of air changes will vary considerably according to the type of work and the conditions of the workshop.

Although it is impossible to eliminate noise completely in our own industry, attention should be paid to this factor wherever possible. Very little evidence is forthcoming to prove that noise impairs efficiency, but it certainly has an adverse effect on energy, especially when it is of an intermittent nature as opposed to continuous.

Little or no attention seems to be paid to the surrounding colours in industry. Generally, light shades should be favoured as these are accepted as being restful.

Having satisfied ourselves that we have attained the best working conditions according to the circumstances we can then pass on to the actual investigation of the job itself.

Job investigation can be split up into three different methods, which are all directly connected with each other.

For jobs consisting of simple operations and for the determination of the best positions of tools and materials, the basic principles of movement study can be applied directly. The job should be accurately time studied in its original form, then after improvements have been made to conform with motion study principles, time studied again to provide a comparison between the two methods.

In jobs which are more intricate, and thoughts are not immediately obvious, a more systematic method of investigation is required. Processed charts can be used to record movements of jobs and human movements in doing the jobs. This method is particularly useful when installing new equipment or altering the layout of a shop. To start with we should study the job carefully and record every operation that takes place. This is best done by means of a type of shorthand. Symbols can be used to represent particular operations so that the sequence of events can be easily followed. Having completed the chart for the job in mind we should make a detailed analysis of it and begin to build up a new method, if necessary, on paper.

During the examination of the chart we must remember that we want to eliminate any unnecessary effort and to reduce effort to a minimum.

We should ask ourselves whether the operation is essential—if not, can we eliminate it in any way? Can any of the operations be simplified by applying the basic principles of motion study? Can the work be reduced by carrying out the operations in a different order? Can we in any way combine two operations into one set up to be performed by one person?

Bearing these points in mind a new method can be organised on paper. Consultation should take place with the supervisor of the department concerned to be assured that quality of the ware will not suffer by the proposed new arrangements. Not until all the details have been finalised can we go ahead with our improved method with any degree of certainty. One mistake in the planning could upset the whole of the following sequence, and time, effort and money would have been wasted.

When the workers have become thoroughly conversant with the new method, it is useful to time study the whole job as a comparison with the original—if only to satisfy yourself that the effort has been worth while.

Sometimes the movements of practised workers are much too fast for an observer to note many of the essential facts. In cases such as these and in jobs which produce extra large quantities the use of motion photography is advocated. It is well to mention whilst on the subject of photography that

still photographs produce much useful information. A few photographs taken from various view points of a workshop before investigation are a great help when arranging a new layout of the shop. Photographs of the positioning of tools and fixtures are also useful for future reference.

Moving Pictures for Instruction

The use of moving pictures are invaluable when instructing new persons on a job. The films can be taken at normal speed and then reduced when projecting on to a screen. It enables us to see clearly the movements in an operation which probably could not be performed slowly by an operator for the purpose of demonstration. Very often a worker uses different movements when operating at slow speeds than he would under normal conditions.

Even with the use of moving pictures it is sometimes difficult to visualise the movements needed. To overcome this the chronocyclegraph can be used. This is simply a method of recording the path of movement during a cycle of work. A photograph is taken of the operator doing the job, wearing lighted flash lamp bulbs on the hand. The result of the photograph is a white line on the picture, tracing out the path of movement.

An even greater improvement on this is the use of a stereoskopic camera, which when viewed through the proper equipment gives a record of the path of movement in three dimensions.

The next step forward is to determine the speed at which the hands are moving in the path. This is done by passing the flash lamp bulbs through a mechanical drive so that they switch on and off in rapid succession. The speed at which the hands are moving can then be determined, as the number of flashes per minute are known. This method also indicates where the hands are accelerating or retarding, because the dashes of light would be stretched out when moving fast, and vice versa.

By making the flashes diminish in brightness from beginning to end the direction of travel can be seen. The dashes on the picture will fade out in the direction in which they travel.

To complete the device it is necessary to have some means of measuring the distance travelled by the hands. This can be done by taking a photograph of a black sheet with 3-4-in. squares on it in the same plane as the job to be studied. Then this can be re-exposed with the actual photographing of the job. In this way a square network of known dimensions appears on the photograph of the job. From this it is easy to determine the distance travelled.

It is well to remember that the photographic method should only be used in fast moving jobs, and only then if satisfactory results can not be obtained from any of the other methods of investigation.

Ridiculous Extremes

The usefulness of photography in motion study has been put to ridiculous extremes in some cases, as in micro-motion photography. A gentleman by the name of Gilbreth started the ball rolling by trying to measure the time taken for such things as grasping an article, the mental process of locating an article, the process of getting a tool in the correct position for use, of letting go of an article. These processes take very little more time than ·002 min. and the value of the knowledge of them to me seems negligible. It costs more to investigate by such method than it is really worth in the end.

Too many managers insist that there is one best way of doing a job. But what is the one best way for one worker does not always mean it is the best for another. No two people are alike either in physical attributes or mental.

It can probably be said that there is one best way as far as layout of shops, tools and materials are concerned, but the movements of workers should be guided by the general principles according to his adaptabilities.

If the co-operation of workers could be gained, knowing that motion study could help them as well as the manufacturers, I am sure that a lot could be done for our industry in this way. Unfortunately a great deal of harm has been done to the prestige of motion study in the past by manufacturers using motion study to increase production without a suitable adjustment in wages.

MASS PRODUCTION IN GLASS

by

R. H. WARRING

THERE are two basic methods of manufacturing hollow or shaped glassware—pressing and blowing. Both follow the traditional manual methods of making glass articles although, of course, most modern production of this nature is done by automatic or semi-automatic machines. It is interesting to note, however, that the original method of making hollow glassware was by casting or modelling the glass around a destructible core, such as sand, formed on the end of a metal rod. Blowing as a method of producing hollow articles came very much later; and pressing later still.

In modern production practice blown glassware and pressed glassware are normally considered as distinct from one another, although the two methods do overlap to a certain extent. For example, certain types of blown glassware are actually the result of combined pressing and blowing actions, although still referred to as "blown" work. The majority of blown glassware requires a final finishing operation to trim off the top or neck whilst pressed ware is normally finished in the one pressing operation. The alternative methods of manufacture can then be considered under separate headings, viz.:

Blown glassware.—Paste mould ware; pressed and blown ware; manual or hot-iron moulding.

Pressed glassware.—Block (plain) mould pressing; split mould pressing.

In paste mould blowing (Fig. 1.) the blowpipe loaded with a gob of semi-molten glass is lowered into a shaped mould and the blank subsequently blown out against the walls of the mould. The method is applicable to either manual of machine operation.

To obtain as fine a surface finish as possible the inside surfaces of the moulds are lined or coated with a suitable paste which is kept wet throughout the operation. This provides a steam layer separating the actual glass envelope and the mould walls, enabling the glass to be rotated as it is blown. The result is a gloss, or polished surface, produced on the resulting blown product.

Tumblers, beakers, light bulb envelopes, flasks, etc., are typical articles produced by paste mould blowing. For machine operation the method

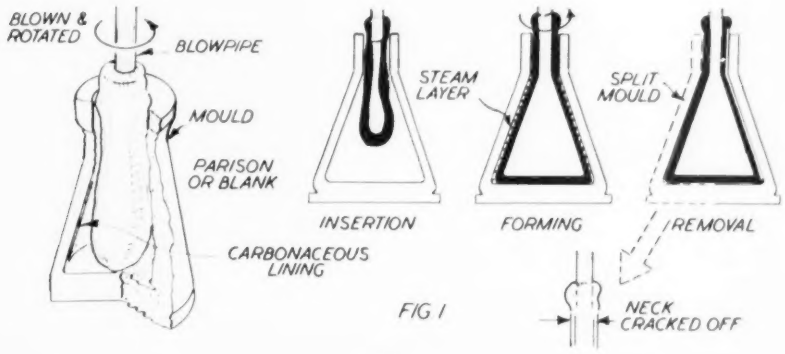


FIG 1

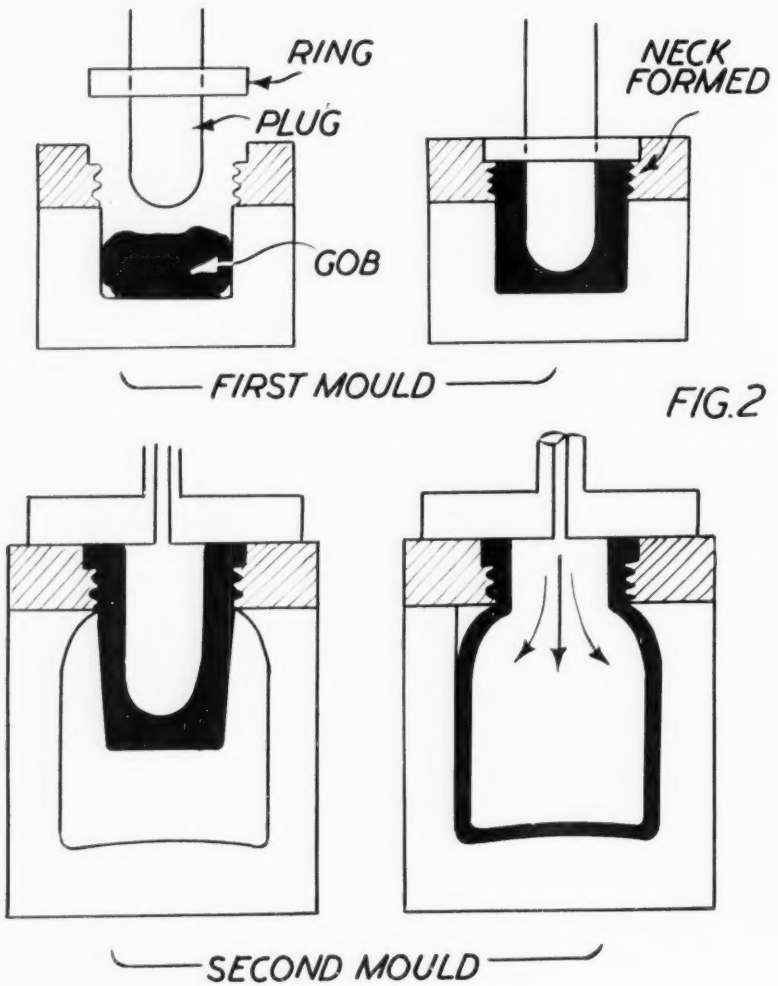


FIG.2

becomes particularly economic on long runs, and for the smaller sizes of pieces. Any article of this nature over about 1 lb. in weight would normally be produced by manual operation up to a nominal limit of, say, 35-40 lb. The normal range of physical dimensions is from 3-10 in. long and a maximum height : diameter ratio ranging from 1·5 : 1-3 : 1 for machine production; and height 3-30 in. and height : diameter ratio between 3 : 1 and 10 : 1 for manual operation. Manual operation is also somewhat more flexible as regards the permissible ratio of the neck diameter to the body diameter, with a maximum value of about 1 : 5, as compared with 1 : 3 for machine production. Also somewhat sharper radii can be blown in at corners, if required.

The nominal range of wall thickness produced by paste mould blowing is 0·06-0·07 inches for thin-walled stock and 0·1 in. heavy-walled stock (machine) or 0·1-0·25 in. heavy-walled stock (manual). Tolerance on wall thickness is of the order of plus or minus one-third in all cases. Some further comparative data are summarised in the accompanying Tables.

NOMINAL DESIGN LIMITATIONS*

Method	Max. dia. (width) in.	Max. height (depth) in.	Max. body : neck dia.	Max. weight (lb.)	Wall thickness in.	Min. Corner Radii
Blowing (paste mould) (manual)	20	30	5 : 1	35	·06-·25	Dia./10
(machine)	6-7	10	3 : 1	1	·06-·10	Dia./5
Press-and-blow (machine)	6-7	12	6 : 1	3-4	·06-·18	$\frac{1}{4}$ in.
Hot-iron mould (manual)	20	30	5 : 1	35	·06-·25	Dia./10
Press mould (manual)	24	12	2 : 1	20	$\frac{1}{2}$-3	$\frac{1}{4}$-1 in. depending on size
(machine)	18	12	1·75 : 1	10	$\frac{1}{2}$-3	
Font mould (manual)	$2\frac{1}{2}$	12	—	5	—	—
(machine)	$2\frac{1}{2}$	10	—	4	—	—

* *Based on data supplied by the Corning Glass Works, U.S.A.*

APPROXIMATE LIMITATIONS—DEPTH (HEIGHT) DIAMETER (WIDTH) RADIUS

		Diameter sizes				
		1-3 *in.*	3-5 *in.*	5-7 *in.*	7-10 *in.*	10-20 *in.*
Paste mould ...	(manual)	10 : 1	6 : 1	6 : 1	3 : 1	3 : 1
" " ...	(machine)	3 : 1	2 : 1	$1\frac{1}{2}$: 1	$1\frac{1}{2}$: 1	—
Press-and-blow ...	(machine)	3 : 1	2 : 1	2 : 1	—	—
Hot-iron	(manual)	10 : 1	6 : 1	5 : 1	3 : 1	3 : 1
Press mould ...	(manual)	$1\frac{1}{2}$: 1	2 : 1	2 : 1	2 : 1	2 : 1
" " ...	(machine)	1 : 1	$1\frac{1}{2}$: 1	$1\frac{1}{2}$: 1	$1\frac{1}{2}$: 1	$1\frac{1}{2}$: 1

MINIMUM ECONOMIC PRODUCTION RUNS

		Nominal sizes applicable to manual forming		
		Small (8 *oz.*)	*Medium* (5-10 *lb.*)	*Large* (20-30 *lb.*)
MANUAL	Paste moulding	1,000	350	50
	Hot-iron mould	2,000	700	50
	Press moulding	1,200	800	500
	Font moulding	1,000	500	—
MACHINE	Paste moulding	100,000	75,000	—
	Press-and-blow moulding	150,000	100,000	50,000
	Press moulding	50,000	35,000	25,000
	Font moulding	50,000	25,000	—
		Small (2-4 *oz.*)	*Medium* (1 *lb.*)	*Large* (3-5 *lb.*)
		Nominal sizes applicable to machine forming		

* *Based on data supplied by Corning Glass Works, U.S.A.*

Production of holloware by pressing and blowing is essentially a machine operation. The gob is loaded into a press mould and the neck shaped and sized, after which the blank is transferred to a second mould and blown to final shape. (Fig. 2.) The resulting product is complete and requires no further finishing (unlike paste mould blowing where the neck or top has to be trimmed after removal from the mould).

One of the main advantages of press-and-blow production is that the shape of the article does not have to be circular or symmetrical. Also screw threads, etc., can be formed on the neck, lettering or graduations embossed or formed on the walls, and so on. The surface finish, on the other hand, is not as smooth as produced by the rotating action of the first method.

To be economic, fairly large production runs are required—of the order of 150,000 minimum for small articles (say up to 2 in. dia., 2-3 in. long and weighing up to 3 oz.); 100,000 minimum for somewhat larger articles (2-4 in. dia., 3-6 in. long and up to 1 lb. in weight); and 50,000 minimum for large articles. Normal maximum limits are diameter 6 in., height 12 in. and weight 3-3½ lb.

Shapes best suited to press-and-blow production are those which fall into the following general specification. Height : diameter ratio should be of the order of 3 : 1. Neck : diameter ratio should be between 1 : 3 and 1 : 6. The ratio of the length to the diameter or width should approximate to 2 : 1. Tolerances on wall thickness may be held to about plus or minus one-quarter, with actual thicknesses similar to the first production method described.

Larger pieces of non-circular section are normally made by hand methods in a plain or "hot-iron" mould (Fig. 3). Circular pieces may also be formed by this method where raised lettering, etc., is required, since the work is not rotated in the mould. The full size ranges possible by this method are essentially similar to those described for manual paste mould blowing.

In the over-all picture, therefore, considering both production costs and production techniques available for blown glassware, minimum production runs for alternative (manual or machine) methods are roughly :

Manual operation.—Paste mould : 1,000 for small articles (8 oz.); 400 for medium articles (10 lb.); 50 for large articles (40 lb.). "Hot-iron" mould : 2,000 for small articles; 750 for medium articles; 50 for large articles.

Machine operation.—Paste mould : 100,000 for small articles (4 oz.); 75,000 for other sizes. Press-and-blow : 150,000 for small articles (3 oz.); 100,000 for medium articles (1 lb.); 50,000 for large articles.

The figures in brackets refer to rough size limits (in terms of weight of glass) in the categories listed.

Allied to these figures, the limitations of the alternative methods must be considered, viz. :

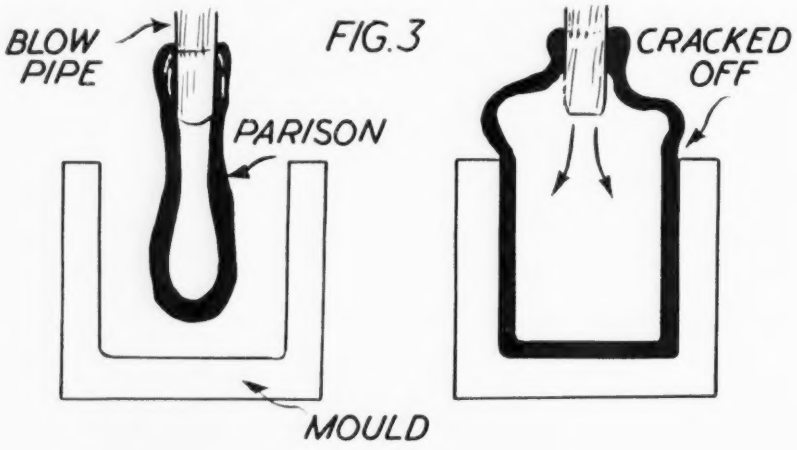


FIG. 3

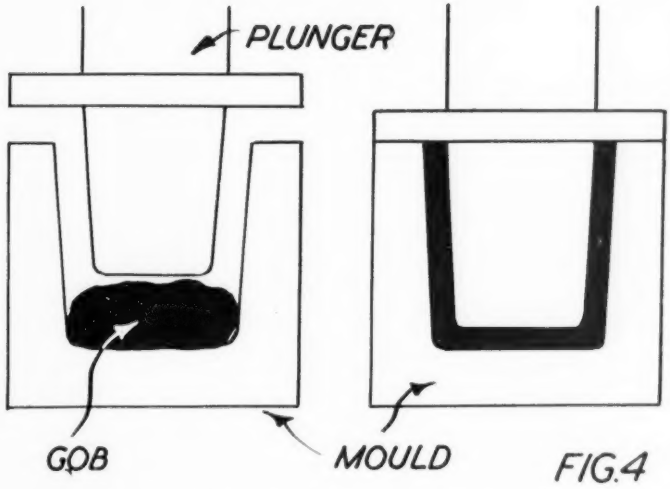


FIG.4

Paste moulding.—Applicable only to smooth circular sections; necking operation required.

Press-and-blow.—Inferior surface finish.

"Hot-iron" mould.—Inferior surface finish; necking operation required.

Either of the latter two methods are capable of accommodating asymmetric shapes, providing raised lettering, etc., whilst the press-and-blow method also enables screw threads, etc., to be formed on the neck of bottles or jars.

The somewhat greater flexibility of manual production as regards dimensional limits may also be of significance.

The second basic production method is pressing. This is capable of producing a wide variety of shapes and sizes in a finished state in a single operation. Both manual and machine methods may be employed, the governing factor usually being the production run required. There is less variation in the maximum sizes which can be produced manually or by machine, but a marked

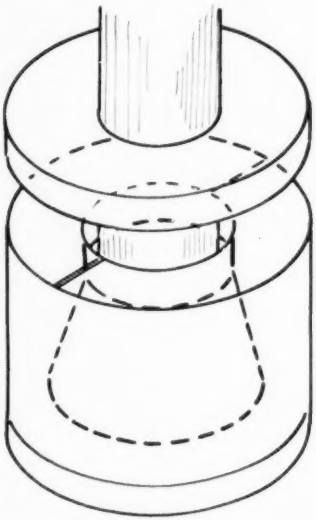
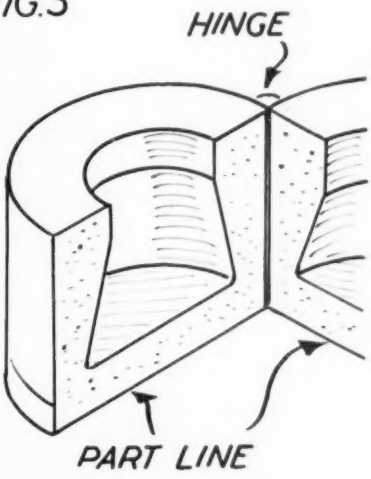


FIG.5



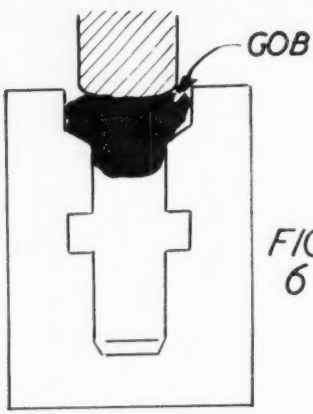
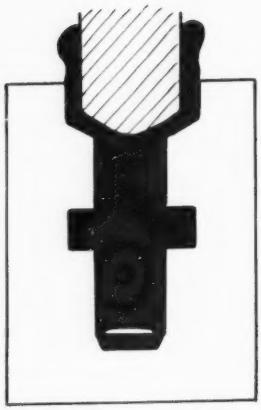


FIG. 6



superiority shown by automatic production in the smallest sizes.

In general, the moulds used take one of two forms—a solid or split mould. The charge or gob of molten glass is introduced into the mould and then pressed into shape with a plunger fitted with a ring. The function of the ring is to clamp down on top of the mould and form the lip or rim (if required). Normally, there is no provision for any excess glass to escape and so the mass of the charge must be carefully controlled. The plunger will tend to travel down into the mould until the glass is forced up around the walls of the mould, tight against the rim, preventing any further movement of the plunger. If the charge is in excess of or deficient from that required then the bottom of the resulting article will either be excessively thick or excessively thin.

Plain moulds (Fig. 4) are the simplest and cheapest for the production of pressed ware and are suitable for a variety of shapes which can be withdrawn readily after forming. A slight taper on the walls is desirable for easy removal. Split moulds are used for shapes which could not otherwise be withdrawn after moulding (Fig 5), in which the mould is hinged to open for removing the finished piece. The actual pressing operation is the same in either case. About the only noticeable difference in the finished product, apart from the typical shapes, is the presence of a certain amount of flash corresponding to the mould parting lines on a product made in a split mould. No article which could be produced in a plain mould would normally be produced in a split mould on account of the higher cost of the latter.

Nominal specifications for pressed productions differ slightly according to whether the article is produced manually or by machine. With manual production a diameter range of from 1-24 in. represents extreme limits, with corresponding weights ranging from about 8 oz. to some 20 lb. Machine production limits are roughly $\frac{1}{2}$-18 in. and from 2 oz. to 10 lb. Corresponding height : diameter ratios are 1·5 : 1-2 : 1 (manual) and 1 : 1-1·75 : 1 (machine). With rectangular-shaped pressings a maximum length : width ratio of 2 : 1 is normally fixed for manual production and between 1 : 1 and 1·5 : 1 for machine production. Unlike production by blowing, of course, wall thickness can be fixed quite accurately to almost any figure required within a normal range of between 3/32 in. and $\frac{1}{2}$ in.

There is a further variation of pressing in which the possibility of variations occurring in bottom thickness, mentioned earlier, are eliminated by allowing the glass to overflow past the top of the mould. This method, sometimes known as font moulding (Fig. 6) is normally restricted to the production of solid glass articles of relatively high length : diameter ratio, such as stoppers, etc. The plunger in this case does not extend into the moulded article but acts merely as a ram to load the charge into the mould cavity. The completed pressing subsequently requires necking or trimming off to the required length. Hollowed articles are also produced by

this method, using a suitable core or cores attached either to the mould or plunger, or both.

Nominal size ranges for font-moulded pressware are—diameter ¼-2½ in. (manual or machine) and weights 2 oz. up to about 5 lb. (manual or machine). The height of the finished product may range up to 12 in. with a very wide range of height : diameter ratios. One of the specific advantages of font moulding, incidentally, is that it does permit the moulding of holes directly in the finished work. Holes in other types of pressed ware have either to be drilled (in which case a locating hole or holes for the drill is usually formed with the pressing) or produced by grinding off appropriate bosses moulded in with the pressing.

LATEST DESIGNS IN TABLEWARE

"Round the Table" is the title of an exhibition of British tableware which the Council of Industrial Design is showing at the Tea Centre, Lower Regent Street, London, S.W.1, from 28th October to 20th November.

The display, devoted to the best current designs in British pottery, glass, cutlery, ovenware and kitchen equipment, will be divided into three groups representing breakfast, luncheon, and tea or supper; each group will consist of three furnished settings showing tables laid with low-, medium- and high-priced tableware. Other stands will display individual items. The designer of the exhibition is Margaret Casson, A.R.I.B.A.

"THE STORY OF FINE CHINA"

At the National Film Theatre, London, on the 7th October, 1953, W. T. Copeland and Sons Ltd., presented to a selected audience a film entitled *The Story of Fine China*. This was originally conceived as an entertaining as well as an instructive means of showing Copeland's agents, and retailers of chinaware all over the world, something of the interesting story behind the fine china and earthenware which they supply to the public.

A sound picture, using colour to great effect, it illustrates how much traditional skill and craftsmanship has gone into the millions of pieces of Spode china which, since the time of George III, have found their way from Stoke-on-Trent into the houses of many lands. The film is 16 mm., running time 40 minutes.

Inquiries about the film should be addressed to Mathew Crosse and Associates, 55 York Terrace, London, N.W.1. Telephone: Welbeck 3776-7-8.

Exhibitions.—To Mr. Kenneth Bridges, managing director of F. W. Bridges and Sons Ltd., our congratulations on the celebration of his fortieth anniversary as an organiser of trade exhibitions, exhibitions which attract annually thousands of home and overseas buyers. The Engineering, Marine and Welding Exhibition at Olympia this year was the twenty-first post-war exhibition organised by Mr. Bridges, and at a luncheon just before the opening he mentioned that the first exhibition he personally supervised was at Stoke-on-Trent in 1913. He was then 17 years old. It is a family business for his father began organising exhibitions in 1896.

Correspondence

NEW INTERMITTENT DECORATING KILN

SIR,—We were most interested to read the recent article (p. 322 of September issue) on what was described as a New Intermittent Decorating Kiln. We read the technical details with particular interest and noted the apparently considerable amount of work and money which has gone into this product. But we sought in vain for anything essentially new or improved. We were a little surprised also to note the limitation of this kiln to decorating and noted that development was to go ahead on similar kilns for biscuit and glost.

The special trolley feature of this kiln is now quite old, both in single and twin chamber arrangements. We built our first trolley hearth kiln over twenty years ago—with a hearth 18 in. × 36 in. and suitable for temperatures to 1,100° C. The kiln was heated only in the sides (as in the recently announced kiln) but it embraced the fully insulated hearth and door in one unit, with a parallel fit into the kiln thus eliminating the problems inherent in hinged and drop down doors. In 1932 we built larger models, many Kanthal heated, for firing refractories and pottery. In 1940 and throughout the war we designed and built several similar kilns for use on Royal Navy repair ships—for heating of castings, etc. By 1945 we had developed several standard sizes for pottery work with the necessary speed and temperature indicating (or controlling) gear to allow their use for all phases of work—biscuit, glost, decorating. Except for the very early models, over twenty years ago, we have been distributing the heating over all faces of the chamber (normally except the roof) including the trolley door and floor and have been able to arrange the heat distribution to acceptable limits without the necessity of employing differently rated elements. Variation of distribution can be achieved, if it is required, by the use of the very simple controls.

All of our several installations have been of the single trolley type, but the twin chamber has had some popularity. We have a further alternative which is to provide a single furnace, but with two trolleys and a small turntable fitted in the rails. This shows some saving in capital outlay, in running cost and in floor space while still allowing one trolley to be unloaded and repacked while the second trolley is being fired.

We now only list three standard sizes of these trolley hearth kilns, but the method is now well proven by years of experience and use and we continue to build all of various styles in endless variety of special sizes in an endeavour to meet the production requirements of users. We felt that your readers may be interested in this further news of a well-proved method, should you have space to publish it.

F. A. E. WALFORD,
Director,
for *R. M. Catterson-Smith Ltd.*

ADVERTISERS' INDEX

A CORONATION TRIBUTE FROM SCOTLAND TO AMERICA

Two of Britain's biggest export commodities combine to produce a luxury consignment which is now on its way to America. These are Scotch whisky and pottery in the form of Coronation souvenir bottles containing a special blend of spirit which has been maturing in oak casks for more than twenty-one years.

The idea behind this unusual example of co-operation in the export field was to produce a whisky and a bottle which would suitably commemorate the Coronation of Her Majesty and, at the same time, add to the great prestige which these industries already enjoy in the U.S.A. It is perhaps the finest quality blend of whisky that has been exported for many years and the initial order for 30,000 bottles is well on the way to completion.

The design and manufacture of the unique earthenware bottles was carried out at the Royal Doulton Potteries at Burslem. Each container is specially fired in order to achieve the desired glaze and colouring. Metal labels show the Royal Coat of Arms of the manufacturers and indicate also, that the production is in commemoration of the Coronation.

The Royal Doulton flagon specially designed for the Scottish whisky consignment which is being sent to the U.S.A. It holds over 26 fl. oz. and it is made in fine earthenware which has been specially fired in order to give a particular colouring effect before dipping in a coloured glaze. The flagon is seen here with and without its velvet "Coronation" cover

FURANE RESIN SUPPLIES

WE understand, from Leicester, Lovell and Co. Ltd., North Baddesley, Southampton, manufacturers of synthetic resin and casein glues, that they are now in a position to supply a range of furane resins.

These resins, which are being marketed under the name "Cascote," are claimed to have many remarkable properties. They show outstanding resistance to weak and strong acids, alkalis and solvents; their hard and durable surface makes them exceptionally resistant to erosion and abrasion whilst resistance to high temperatures is extremely good, being surpassed (amongst thermosetting plastics) only by the silicones. They have, of course, the black or dark brown colour characteristic of furnace resins.

Particular advantages of these furane resins are their long storage lives, the fact that they do not suffer from the exotherm usually associated with furane resins, and their improved adhesion to metal. The range includes materials which will harden at both room and elevated temperatures.

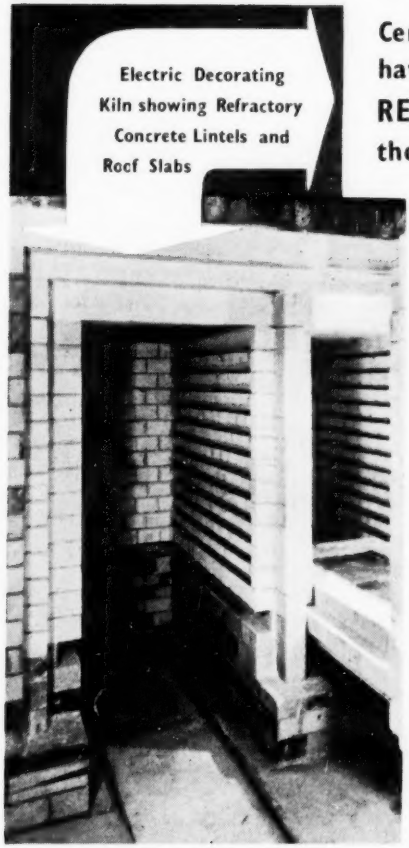
The properties detailed above will have a considerable appeal in many fields of industry and particularly for such applications as chemical plant coatings, impregnation of Dufaylite, protective surface coatings, heat-resistant glass fibre laminates, etc. Inquiries for further information and samples should be addressed to the Technical Sales Manager, Leicester, Lovell and Co. Ltd.

NEW QUICKFIT CATALOGUE

Quickfit and Quartz Ltd., manufacturers of interchangeable laboratory glassware of Stone (Staffs) have issued a new catalogue describing their range of products.

The object of the new catalogue is to depict the range of Quickfit interchangeable laboratory glassware. Quickfit standardisation embraces the dimensions, designs and finish of the whole apparatus and is not confined to ground connections. The catalogue lists and illustrates typical pieces of apparatus built entirely of standard Quickfit components in general use. Apparatus of a more specialised character, such as Soxhlet Extractors, is also shown in the catalogue.

Where more than two components are involved, the assembly is provided with its own catalogue number to simplify ordering.



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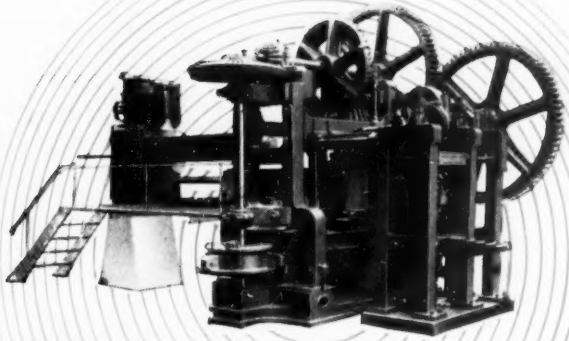

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